176608

SOLUTIA

IMPLEMENTATION OF SLURRY WALL CONSTRUCTION

GROUNDWATER MIGRATION CONTROL SYSTEM

SAUGET AREA 2 – SITES O, Q, R AND S

SAUGET, ILLINOIS

Submitted To:

United States Environmental Protection Agency
Region V
77 West Jackson Blvd.
Chicago, Illinois

Submitted By:

Solutia Inc.
500 Monsanto Avenue
Sauget, Illinois

April 24,2003

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1. Introduction

During the preparation of the Focused Feasibility Study (FFS) for the proposed Interim Groundwater Remedy at Sauget Area 2, Sites O, Q, R and S, a number of general response actions were evaluated. These included both physical and hydraulic barriers. More particularly, two types of physical barriers, slurry walls and jet grouted walls, were selected for screening. Based on an evaluation of the technologies, at least as they were understood at that time, the use of a slurry wall as a physical barrier was screened out from further consideration. The specific areas of uncertainty identified with the use of this technology were:

- The ability to reliably construct the wall to a depth of 140 feet;
- The ability to key the wall into bedrock; and,
- The ability to use the excavated soil as backfill in the slurry trench.

These uncertainties, particularly the latter, were judged to be significant enough to preclude the technology from further consideration in the assembly of remedial alternatives. Jet grouting technology appeared to offer less uncertainties, primarily because the spoil produced by the construction operation was expected to be much less than that produced by a slurry wall. Consequently, the problem of disposal of large volumes of spoil was not expected to be significant if jet grouting was used to construct the barrier. Accordingly, the preferred remedial alternative included the construction of a jet grouted barrier wall and this alternative was selected as the preferred remedy in the Record of Decision (ROD).

In March 2003, bids were solicited from a number of specialist contractors for the construction of the barrier wall using jet grouting techniques. One of these contractors, Inquip Associates, submitted an alternate bid based on the use of conventional soil-bentonite slurry wall techniques. During an interview, Inquip was able to demonstrate to Solutia's satisfaction that such construction was feasible. In fact, this system appears to offer at least as much certainty about the integrity of the finished product as jet grouting, and perhaps even more.

This new information was verbally presented to the U. S. Environmental Protection Agency (EPA or Agency) at a meeting on March 24, 2003 and the possibility of the Agency approving the use of conventional soil-bentonite slurry wall techniques to construct the barrier wall downgradient of Sauget Site R was then discussed. In order to permit the Agency to evaluate a request for such approval, Solutia was asked to prepare this report re-evaluating the areas of uncertainty identified in the FFS, in light of the newly obtained information.

Each of these areas is separately addressed below. The report also contains a discussion of the advantages offered by use of conventional slurry wall construction techniques. In addition, if a conventional soil-bentonite slurry wall is accepted for use on this site, it is understood that some period of time (possibly several months) will be required to amend the Administrative Record to reflect that change. In order to accommodate this possibility, while still working to mitigate groundwater impacts to the river, Solutia proposes to install the groundwater extraction and disposal system ahead of the rest of the remedy. In this way, pumping can be started before the wall is installed, if necessary. Thus, the report includes discussions regarding the suitability of the monitoring network proposed in the FFS for use in the absence of a barrier wall.

Finally, Inquip was requested to provide Solutia with case histories of slurry walls similar to that proposed for Sauget Area 2 and to provide any information that would assist in demonstrating that construction of the proposed slurry wall is feasible. The requested information is presented in Attachment A of this report. While this information has been used in preparing the report, it is emphasized that other contractors, in this country as well as in Japan and Europe, have similar experience records and equipment. Consequently, Inquip should not be considered to be a sole source provider.

2. Slurry Wall Depth

One of the major issues in successfully constructing a deep slurry wall is the ability to maintain a stable trench over a long distance and to keep the trench bottom and long back slope free of debris. This requires the careful design of the slurry mix and the selection of the right equipment for excavation of the slurry trench.

Inquip proposes to engage the services of one of the leading slurry wall consultants in the country, Meuser Rutledge Consulting Engineers, to design the slurry mix. Meuser Rutledge have designed and provided construction inspection services on a large number of slurry trench projects around the world, including slurry walls for the original construction of the World Trade Center in New York City, as well as for the Post 9/11/01 recovery efforts at this site. They have performed stability analyses for the trench proposed for Sauget Area 2 and have concluded that it will be stable as long as the slurry density exceeds a critical value of 70 pounds per cubic foot (lb/cu. ft.). On this basis, they have recommended that the slurry mix be designed to provide a density of 78 lb/cu. ft., which will result in a factor of safety against failure of 1.24. This density will be readily achievable with the soils at the site. A letter from Meuser Rutledge discussing the stability of the proposed wall is included in Attachment A.

Inquip also proposes to use some of the most advanced and innovative equipment available for construction of slurry walls. The proposed construction method will involve the use of a backhoe with a 108 foot long boom to excavate the trench to a depth of 80 to 90 feet. The backhoe is specifically designed for construction of slurry trenches and will ensure rapid production while maintaining a clean trench bottom. A photograph of a backhoe similar to that proposed for use on this project is shown in Attachment B.

Below this depth, the contractor proposes to advance the trench using a hydraulically operated clamshell bucket. The clamshell was developed in France by Soletanche Bachy, one of the world's leading slurry wall contractors, specifically for excavating slurry trenches beyond the depth capability of a backhoe. The system is automatically controlled such that the position and orientation of the clamshell is precisely known at all times. This ensures the overlap of successive cuts, as well as the verticality and required penetration depth of the trench.

Inquip has used this combination of equipment on a large number of deep cut-off walls in the past, including one in Milford, New Hampshire to a depth of 110 feet, one in Crogan, New York to a depth of 120 feet, and another in Kansas City, Kansas to a depth of 106 feet. Equipment owned by Inquip (including the KS 3000 clamshell bucket proposed for use on this project) was recently used by another contractor to install a slurry wall to a depth of 195 feet in New York. Manufacturer's equipment specification sheets for the KS 3000 are included in Attachment A, as is a list of deep slurry wall projects completed by Inquip.

3. <u>Bedrock Contact</u>

The FFS noted that it is difficult to key a slurry wall into the top of bedrock. However, as also noted in the FFS, terminating the slurry wall at the soil-bedrock interface is practicable because the amount of groundwater flow through weathered or fractured bedrock is likely to be a very small fraction of the flow in the alluvial aquifer. Consequently, the slurry wall proposed for this project will not be keyed into bedrock. Rather, it will sit directly on top of the rock, in the same way that the current design for a jet grouted wall terminates the wall on top of the rock. In consequence, the hydraulic performance of the slurry wall will be equivalent to that of the jet grouted wall, in terms of the relative insignificance of any possible underflow.

One of the factors influencing the success of a slurry wall installed to the top of rock is the ability to clean the bottom of the trench (top of rock) prior to backfilling. The clamshell proposed for use on this project is particularly suited to this task. The supplemental information included in Attachment A discusses the measures that have been used on previous projects to ensure intimate contact with rock and these same measures will be used on this project.

4. Use of Excavated Soil for Trench Backfill

At the time that the FFS was prepared, it was not known whether the excavated soil could be used as backfill for the slurry trench. Since that report was prepared, however, an extensive compatibility testing program has been completed. The results of that testing program, which were presented in Volume 1, Attachment 4-2, of the Prefinal-Design Report submitted to EPA on January 21, 2003, demonstrate that the soils excavated during the construction of the slurry trench can be used as backfill without compromising the long term performance of the slurry wall.

5. Advantages of Using a Soil-Bentonite Slurry Wall

The FFS concluded that a soil-bentonite slurry wall was not a viable alternative for a physical barrier, primarily because of the uncertainty about the ability to reuse the soil excavated for the slurry trench as backfill for that trench. The costs for off-site disposal of the soil made this alternative cost prohibitive if it could not be reused and, in consequence, this type of physical barrier was not carried into the detailed analysis of alternatives. However, now that it has been established that the constituents in the excavated material will not adversely affect the performance of the wall, there are some advantages offered by the use of this technique that make it an attractive alternative.

These include the following:

- Construction of cut-off walls using soil-bentonite slurry trenches is a proven technology that has been used all over the world for decades. The design principles are well understood and the technology and equipment have been proven. Consequently, the ability to successfully construct a cut-off wall is much less dependent on proprietary processes and equipment than is the case for walls constructed with jet grouting.

- Control of the geometry of the slurry trench, in terms of its penetration depth, verticality, and horizontal alignment is more easily controlled than for a jet grouted wall. This allows for the development of a comprehensive Quality Assurance and Quality Control program. As Inquip notes in the material included in Attachment A, such a program is the key to successfully installing a soil-bentonite wall.

- Since the majority of the excavated soil will be used as trench backfill, the volume of surplus spoil generated from the construction of a slurry wall at the project site will be minimized. At this time, it is estimated that a fully penetrating slurry wall will result in a surplus spoil volume of less than 5,000 cubic yards, as compared to the approximately 30,000 cubic yards expected from the construction of a jet grouted wall.

- Based on the bids received from a number of contractors, it appears that the use of conventional soil-bentonite slurry trench techniques for construction of the cut-off wall will be more cost-effective than other techniques such as jet grouting or deep soil mixing. The performance and reliability of the final product will be very similar using any of these techniques. However, a soil-bentonite slurry wall may be 15 to 20 percent less expensive than other alternatives. While it is understood that cost is not one of the primary criteria used in remedy selection, it is one of the balancing criteria used in comparing remedial alternatives that offer equivalent performance. Further, the CERCLA Model Statement of Work specifically allows for the use of value engineering in the remedial design process.

6. Interim Groundwater Pumping

As noted in Section 1 of this report, it is understood that if the use of a soil-bentonite slurry wall is approved, it may take several months to amend the Administrative Record to reflect that approval. In the interim, it is important that efforts to mitigate any potential impacts from groundwater discharge to the river continue. To that end, we propose to install the groundwater extraction and disposal system by the middle of July 2003, well ahead of wall construction. In that way, if the approval process proves to be protracted, the extraction system can be turned on and the system startup period can begin.

Operation of the extraction system in the absence of a physical barrier was one of the alternatives considered in the FFS (Groundwater Alternative C – Hydraulic Barrier). The alternative was judged to be equally as effective as the physical barrier in mitigating groundwater impacts, although the physical barrier was judged to offer marginally better long term reliability because of its permanence. The major disadvantage to the use of a hydraulic barrier was judged to be the long term cost. As a short to medium term measure, however, it is considered to be very viable.

Operation of the system in the absence of a cut-off wall will not require any changes in the current instrumentation and control systems, or in the monitoring systems. The only differences in the operation of the system are the following:

- The volume of extracted groundwater will be doubled. The required flow rates as a function of river stage were provided in Section 5.3 of the FFS and that relationship will be used to control the pumping rates, as opposed to the relationship presented in Section 5.2 of the FFS. In order to accommodate the additional flow, the diameter of the northern and southern wells will be increased from 10 inches to 12 inches and these will be installed as fully penetrating wells, to the top of bedrock. In addition, pump sizes will be increased to 40 horsepower in all three wells.

- Instead of maintaining equal groundwater levels on both sides of the barrier wall (zero gradient across the wall), the groundwater levels at the hydraulic barrier will be maintained at the same level as the river. This will effectively create a zero gradient condition between the hydraulic barrier and the river, with the result that groundwater discharge to the river from the area downgradient of Site R will be controlled. In order to monitor this head equilibrium, groundwater levels will be measured in the two piezometers placed midway between the northern and middle extraction wells and the middle and southern wells (Figures 1-2 and 5-1 of the FFS). These piezometers will be along the same north-south alignment as the extraction wells. The water levels will be compared with the river level obtained from the river stage gage required by the current design and the pumping rates will be adjusted to ensure that the two water levels are the same.

Because the wall will not be present during the initial part of the pumping, the downgradient piezometers in each of the piezometer pairs shown on Figures 1-2 and 5-1 of the FFS will not be required. Thus, we may elect to defer the construction of these installations until the wall is installed.

No other changes in the operating or monitoring procedures are necessary.

With regard to starting the extraction and disposal system in July, discussions have been held with the Illinois Environmental Protection Agency (IEPA) and the American Bottoms Regional Wastewater Treatment Facility (ABRWTF) about the ability of ABRWTF to accept the extracted groundwater prior to their receipt of a new NPDES Permit. IEPA has indicated that the facility can accept the water under its existing permit and ABRWTF has agreed to issue a discharge permit to Solutia prior to the middle of July 2003.

ATTACHMENT A

dn.mcl/03052

April 11, 2003
McLean Office

Solutia, Inc.
500 Monsanto Avenue
Sauget, IL 62206

Attention: Richard S. Williams, Ph.D., P.E.
Sauget Sites Project Manager

RE: Solutia, Inc., Area 2, Site R
Vertical Groundwater Control Barrier
Request for Proposal

Dear Dr. Williams:

This letter is to address, as per your request, some of the parameters of the slurry trench considered for the above reference project, in particular the selection of this technique in view of the trench depth and the quality of the contact with the bedrock.

For over 40 years, the slurry trenching method has been used extensively in the world for the installation of various types of cutoff's to depths in excess of four hundred feet. Selection of the type of cutoff is dependant upon several parameters:

- The objective of the cutoff, (for instance seepage control below a dam, pollution control, permeability to be achieved, ect.)
- The nature of the soil/rock material to be trenched through, combined with the characteristics and potential of the available trenching equipment
- The size of the cutoff, mostly its depth
- The site conditions, such as space available for construction, presence of structure(s) adjacent to the trench, its topography, ect.
- The stability of the trench, mostly a function of the nature of the soils, the depth of the cutoff, the elevation of the water table, the eventual presence of adjacent surcharges and the length of trench supported by the slurry
- The cost

We have analyzed carefully all these parameters to select the soil bentonite slurry trench technique as the most appropriate and economical type of slurry cutoff to propose as value engineering for the above referenced project.

1 Selection of the Slurry Trench Technique

1.1 Trench Depth

The depth will be close to 140 feet. A main considerations is related to the selection of the equipment for efficient excavation of the trench through the existing soil formations. We have selected a proven combination of equipment for the project, i.e. a backhoe to excavate the overburden to a minimum depth between 80 and 90 feet, and clamshells to extend the trench to 140 feet and clean the top of the bedrock formation. Such combination has been used successfully by Inquip in the past, (see attached list of "Inquip" deep cutoffs.) The performance of Inquip's backhoes for deep slurry trenching has been successfully demonstrated over many years on numerous projects. In addition, we intend to use the most productive type of clamshells available for slurry trenching, the KS 3000 developed by Soletanche Bachy. This is a very powerful hydraulic grab set up on a short Kelly guide, which can excavate to depth in excess of 200 feet. (Inquip's KS 3000 was used recently to excavate a slurry wall to a depth of 195 feet on the Perdegate Basin Project for the New York DEP.) The use of the KS 3000, instead of a conventional mechanical clamshell, presents many technical advantages. Inquip used this same combination on its last two deep projects, the OK Tools Superfund site in New Hampshire, where the maximum trench depth was 110 feet and on the KCPL Coal Dumper project in Kansas, where the maximum depth was 106 feet. As explained further below, both of these trenches were also to the top of rock.

As a conclusion to this section, there is no doubt that the equipment we selected for the project is the most efficient to perform the 140 feet deep excavation and will do so successfully. Attached is a brochure from Soletanche Bachy describing the characteristics of the KS 3000.

1.2 Trench Stability

The stability of the trench is the main concern for the installation of deep soil bentonite cutoffs. This is because a long section of trench is open at any time. Hence, the first task done to select the type of cutoff was to analyze the trench stability taking into account its depth and the existing soil conditions. As you know, we subcontract this analysis to an Independent Consulting Firm, Mueser Rutledge Consulting Engineers, a geotechnical consultant with extensive experience in all types of slurry walls. The conclusion of this analysis was that a "continuously slurry supported trench will be stable as long as the slurry weight and elevation are maintained." Inquip has the experience and quality control procedures to insure compliance with such requirements.

Hence, as far as the critical issue of trench stability is concerned, the conclusion of Mueser Rutledge, as well as ours, is that we can safely install the 140 feet deep cutoff by the soil bentonite method for the project.

1.3 Trench Backfill

The next important issue concerns the quality of the trench backfill. This includes the backfilling operation itself as well as the permeability characteristics of the backfill. Soil bentonite slurry trenches were installed first in the sixties to shallow depth, in the 30 to 40 feet ranges. As additional trenching equipment has been developed, these depths have increased to the sixty feet range, then 80 feet with specialized backhoes, then up to 110 feet with a combination of backhoe and clamshells. The typical backfilling developed and used at the origin of the technique has proven itself suitable each time the depth was increased. We have a thorough knowledge of the backfilling process, and we are convinced that it will be as good at 140 feet as it was at 110 feet on recent projects. As a matter of fact, further research shows that a soil bentonite slurry trench was installed in California to depth up to 148 feet on the San Jose Facility, CA of the Fairfield Semiconductor Corporation, see attachment.

The key to success is to develop an aggressive Quality Control Program. Inquip intends to develop construction procedures and an extensive Quality Control Program to verify the quality of all the operations required for the installation of the trench, in particular the quality of the backfill and backfilling operations. These procedures will include at least the following items:

- Control of the characteristics of the backfill, mostly permeability and slumps at time of placement. The latter is critical to insure the "flowability" of the backfill in the trench.
- Cleanliness of the bottom of the trench prior to backfilling. This is also a critical requirement to maintain an excellent contact between the cutoff and the top of bedrock, an issue discussed further below.
- Control of the unit weight of the slurry, to insure not only trench stability but a successful substitution of the slurry by the backfill.
- Control of the cleanliness of the slope of the backfill.
- Measurement of the slopes of the backfill, and verification of the quantities placed versus the volume backfilled.

This thorough QC program will give you the warranty that we will install a quality soil bentonite cutoff which will exceed the intent of the design.

As a conclusion of this section, the soil bentonite technique is very appropriate, as well as the most economical method, to install a cutoff on your project. It will also yield a cutoff with permeability quite lower that a jet grout cutoff would. This conclusion is based not only based on the above analysis, but also was reached by our Independent Consultant, Mueser Rutledge, (see the attached letter of Mr. Peter Deming, who is also the chairman of the ASTM Committee for Hydraulic Barriers in Soil and Rock..

II. Contact with the Bedrock

It is the design intent to stop the trench on the top of the limestone bedrock. The conventional borings indicate that the top of the limestone is mostly "dense, light gray, smooth textured". Therefore, it seems that we should not expect generally the presence of weathered limestone. The principal requirements will be to:

- Insure that the excavation is stopped on the top of the limestone,(and not a possible boulder.)

➢ Clean the bottom of the trench prior to backfilling.

The following were main concerns on many projects, including the two deep slurry trenches to bedrock already referenced in this letter:

➢ OK Tools Superfund Site, NH: The trench was stopped on contact with granite bedrock. The overlying material included numerous cobbles and boulders also of granite origin. Getting insurance that the trench was stopped on bedrock was a primary concern. The use of the KS 3000, with its powerful jaws, was a key to resolving this issue. A thorough examination of the rock cuttings brought back by the clamshell allowed the QA geologist and our QC Manager to make this critical decision. Rounded cuttings were the indication that we were working on a boulder, whereas fractured pieces of rocks with straight edges and broken surfaces indicated that we were on the top of bedrock. Then a systematic cleaning of the trench bottom was performed everyday prior to the backfilling operation. These measures were used throughout the project. The project was completed in 1998. We understand, from a recent discussion with Mr. Tom Andrews, from the New Hampshire Department of Environmental Services, NHDES, that the slurry wall is behaving beyond expectations. If you want to discuss further this project, feel free to contact Mr. Andrews at the following telephone number: (603) 271-291.

➢ KCPL Coal Dumper, KS: The slurry trench on this project was stopped on the top of sound shale. A 2 to 4 feet layer of weathered shale overlaid the competent shale. Here again, the use of the KS 3000, with a closing force of the jaws close to 300 tons, allowed the excavation of the trench through the weathered material. The slurry trench for this project was also very effective in cutting the seepage into two deep cells excavated for the installation of the coal dumpers. This example demonstrates that the hydraulic clamshell will be able to excavate through localized pocket of weathered limestone if any were to be encountered.

The issue of the contact with the rock is also addressed in Mr. Deming's letter. He refers in particular to another project by Inquip, the Pierremont Hospital in Shreveport LA, where the cutoff was stopped on the top of bedrock. In Mr. Deming's word, the slurry walls for this project and the OK Tools site performed "superbly".

We thank you for the opportunity to address these topics, and hope that the above information will answer your questions. Please do not hesitate to call if you have any questions.

Very truly yours,

Dominique Namy, Ph.D.
Executive Vice President

Attachments

Contractor Qualification Information (*Deep Cutoffs Only*)

Project Information			Owner or Engineer Information			Description of Facility							Equipment Used				
Name	**Purpose**	**Location**	**Name**	**Contact Person**	**Telephone Number**	**Depth (max)**	**Width (ft)**	**Length**	**Type of Excavation**	**Type of Backfill**	**Soil Conditions**	**Hydraulic Conductivity (cm/sec)**	**Backhoe**	**Clamshell**	**D6H Dozer**	**Chiesel**	**CB Plant**
Applewhite Water Supply	Cutoff Wall	San Antonio, TX	Freese & Nichols	Mr. Ronnie Lemons	817.735.7300	100'	4	1250'	Backhoe/ Clamshell	Soil Bentonite	Cemented Sand	$1 * 10^{-7}$	X	X	X	X	
Bingham Canyon Mine	Cutoff Wall	Copperton, UT	Agra Earth Environmental	Mr. Paul Kaplan	801.266.0720	78'	3	250'	Clamshell	Soil Bentonite	Glacial Till/Boulders	$1 x 10^{-7}$			X	X	
Former Tie Treating Plant	Containment	Laramie, WY	Union Pacific Railroad	Mr. R.C.Kuhn	402.271.2261	90'	3	10,500'	Preauger hole/Backhoe/Clamshell	Soil Bentonite	Layered Shale/Sandstone	$1 x 10^{-7}$	X	X	X	X	
Little Flint Creek Dam	Cutoff Wall	Gentry, AR	Freese & Nichols	Mr. Ronnie Lemons	817.735.7300	80'	3	140'	Backhoe	CB/ Concrete	Sandy Clay	$1 x 10^{-6}$	X				X
Manasquan Reservoir	Cutoff Wall	Howell Township, NJ	Woodward Cylde	Mr. Dick Davidson	303.740.2600	80'	3/5	4,600	Backhoe/ Clamshell	Soil Bentonite	Sandy Silt	$1 x 10^{-6}$	X	X	X		
Natural Dam Lake Emergency Repairs	Cutoff Wall	Big Spring, TX	Freese & Nichols	Mr.Don Morsman	913.236.6100	78'	3	2700'	Backhoe/ Clamshell	Soil Bentonite	Sand	$1 x 10^{-7}$	X	X	X		
Quirke Mine	Cutoff Wall	Elliot Lake, ON	Golder Associates, Inc	Mr. Julius Balius	416.567.4444	76'	3	450'	Backhoe	Soil Bentonite	Glacial Till/Boulders	$1 x 10^{-7}$	X		X	X	
Seepage Control, Parcels 1,2,3	Cutoff Wall	Mound City, IL	U.S. Army Corps of Engineers	Mr. Kenneth Ladd	314.333.1043	98'	2.5	9,000'	Backhoe/ Clamshell	cement bentonite	Sandy Silt/Cemented Lenses	N/A	X	X	X		
Soft Maple Dam	Cutoff Wall	Crogan, NY	ABB Environmental	Lyle Tracy	207.775.5401	120'	2.5	300'	Backhoe/ Clamshell	Soil Bentonite	Glacial Till/Boulders	N/A	X	X	X	X	
W.K. Pierremont	Cutoff Wall	Shreveport, LA	Mueser Rutledge	Peter Deming	212.490.7110	88'	3	875'	Backhoe clamshell	Cement Bentonite	Silt/Mudstone/ Sandstone	$1 x 10^{-6}$	X	X		X	X
Whitney Point Lake Cutoff Wall	Cutoff Wall	Whitney Point, NY	U.S. Army Corps of Engineers	Mike Snyder	410.962.4772	81'	3	2,850'	Backhoe	Cement Bentonite	Silty/Sand	$1 x 10^{-6}$	X				X
OK Tool Superfund Site	Cutoff Wall	Milford, NH	NHDES	Thomas Andrews	603.271.2910	109'	3'	1,450'	Backhoe/ KS 3000Clamshell	Soil Bentonite	Sand/Till Contact on rock	$1 x 10^{-7}$	X				
SARC Area Cutoff Wall	Cutoff Wall	Bartow, FL	Farmland Hydro LP	Robert Pyburn	863.533.1141	102'	2.5'	5,000'	Backhoe	Soil Bentonite	Sand, Cemented Sand, Limestone	$1 x 10^{-7}$	X	X	X		
KCPL Coal Dumper	Cutoff Wall	Kansas City, KS	Hawthorn Power Plant	Marvin Rawlinson	816.552.2200	106'	1 m.	1,000	Backhoe/ KS 3000 Clamshell	Soil Bentonite	Silt/Sand Shale	1X10-7	X	X	X		
Coastal Plains Recycling & Disposal Facility	Cutoff Wall	Alvin,TX	Waste Management of Texas, Inc.	Chuck Spann	281.446.6445	78'	3'	8,600'	Backhoe	Soil Bentonite	Clay Sand Clay	1X10-7	X		X		

KS 3000 DIAPHRAGM WALL RIG

FIRST PRIZE 1995 FOR INNOVATION, AWARDED BY THE FRENCH FEDERATION OF PUBLIC WORKS CONTRACTORS

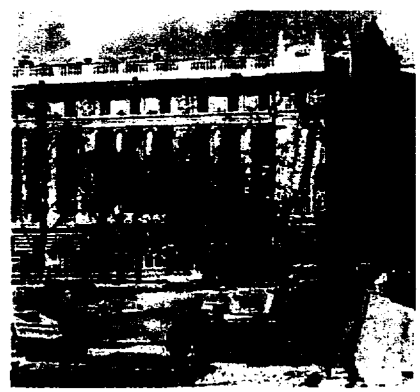
The new urban diaphragm wall concept combines several recent fundamental technical advances in :
- optimisation of grab trenching techniques
- design of hydraulic machinery
- computerised instrumentation, monitoring and control techniques
- optimisation of drilling mud treatment : design of the mud mixing, storage and treatment plant has been completely overhauled to control pollution and to reduce the area it occupies and thereby shorten the time required for site set-up and removal.

PARIS, FAUBOURG POISSONNIERE, KS 3000 SITE

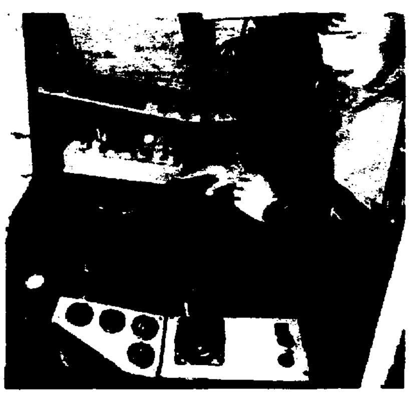
LEADING FEATURES OF KS 3000 RIG

- Standard grab sizes : width 500/600/800/1000 mm, length 2700/3000 mm.
- Total weight crane + KS 3000 : 60 tonnes.
- Horsepower : 330 hp (metric).
- Oil pressure : 30 MPa approx.
- Max trench depth : 60 metres.

NANTERRE, A 86 MOTORWAY



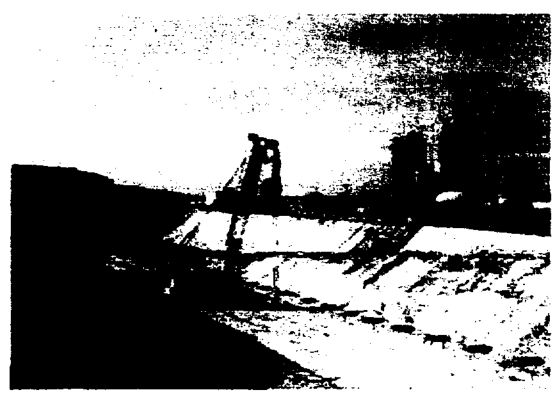
BUDAPEST, SZABADSAG TER



KS 3000 OPERATOR'S CAB

The high performance KS 3000 is also ideal for major linear jobs (like roads) on open sites.

Progress is around 25-30 % faster than with standard plant.



PENLY, DIAPHRAGM WALL FOR SEEPAGE CONTROL

M.B.E. Impressions - Paris - Août 1998

SOLETANCHE BACHY

KS 3000 DIAPHRAGM WALL RIG

FIRST PRIZE 1995 FOR INNOVATION, AWARDED BY THE FRENCH FEDERATION OF PUBLIC WORKS CONTRACTORS

KS 3000 RIG AND URBAN DIAPHRAGM WALL CONCEPT

The high cost of city centre land means that promoters must recoup the most from their investments by building right up to boundary lines on **frequently tiny plots** and burrow underground to provide parking space, often demanded in fact by byelaws. At the same time, **environmental constraints** on construction are becoming stricter, demanding more compact site works, less noise, no interruption to traffic and no nuisance or damage to neighbouring properties.

Lastly, owners are today requiring completely **transparent** works monitoring records and observance of Quality Assurance Plans.

The overall solution to such problems is the diaphragm wall, with the following refinements :

- The wall is built with the **compact**, hydraulically-operated, **high performance** KS 3000 rig which can be quickly prepared on site to trench right up to neighbouring constructions without damaging them.

- The work is **automatically controlled** by the SAKSO system, which also prints out reports. The KS 3000 is a quantum leap in diaphragm wall construction plant :

- It is designed to build diaphragm walls safely with the minimum of environmental disturbance on sites too small for conventional plant.

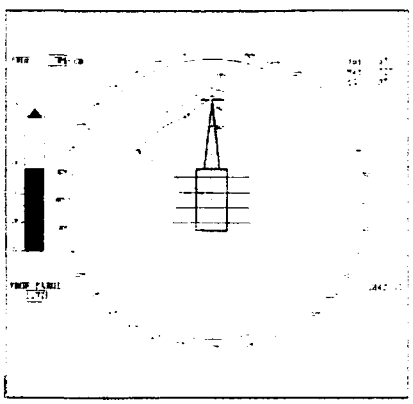
- Construction is quicker at less cost, although the final result is better.

- **Quality control** is enhanced through the automatic printing of realtime reports containing all relevant data (trench verticality, penetration rate, depth, strata, stoppages, etc.)

- Job data is downloaded into a data bank to optimise progress rates and subsequently improve conditions on future jobs.

- Automatic control means better control.

KS 3000 RIG



CRANE OPERATOR'S VDU DISPLAY OF PARAMETERS

Automatically-Controlled Motions

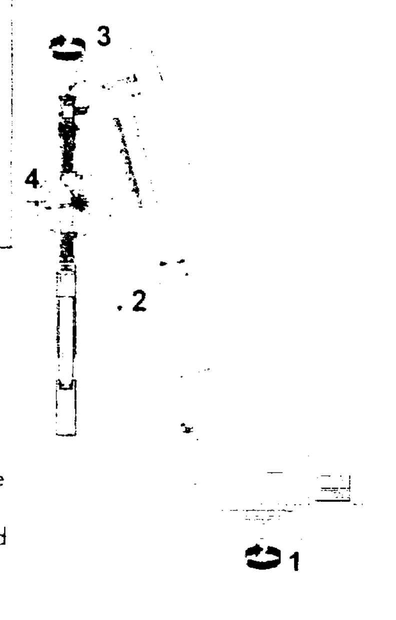
The SAKSO system controls the following crane motions .

- Slew (axis 1)
- Luff (axis 2)
- Grab rotation (axis 3)

Hose reel retract (axis 4)

The control system is programmed in three steps :

- The operator first controls the rig by hand
- He then enters the required movements into memory
- The control system takes over to repeat these movements



SOLETANCHE BACHY

Project 82-012
October, 1988

CanonieEnvironmental

Revised Draft Report

Remedial Action Plan Fairchild Semiconductor Corporation San Jose Facility October, 1988

Fairchild Semiconductor Corporation
San Jose, California

Prepared For:

Fairchild Semiconductor Corporation

Volume 4 of 6
Appendices F through N

The slurry wall was installed as a part of an interim remedial plan to accelerate the cleanup effort and increase its effectiveness. The slurry wall was selected as a remedial action because it was determined to be the most effective method of restricting the migration of the remaining on-site solvents and increasing the effectiveness of subsequent remedial measures. Canonie recommended construction of a three percent soil-bentonite slurry wall near the perimeter of the Fairchild property to create a relatively impermeable barrier that would greatly reduce further solvent migration off-site. The pumping of ground water from the slurry wall enclosure to maintain an inward gradient across the wall is integral to the function of the slurry wall. As a result of such pumping, any seepage through the slurry wall would be inward, and the outward migration of chemical-bearing ground water through the wall would be eliminated.

Depth

The wall is approximately three feet wide and ranges from 80 to 148 feet deep. Past experience with the type of backfill material recommended for the slurry wall indicates that it can produce a relatively impermeable barrier to solvent-bearing water. Construction of the slurry wall began in August 1, 1985, and was completed on May 30, 1986.

Subsurface exploration and site "B" and "C" aquifer water level data verified the continuity of the "B-C" aquitard. Consequently, the slurry wall was keyed into this aquitard a minimum of two feet at all locations to effectively create closure of the "A" and "B" aquifers on-site. A complete documentation of the installation of the slurry wall is contained in Reference N-5.

The purposes of the slurry wall are to contain the area of highest remaining chemical residues on-site and to reduce the time and amount of ground water extraction off-site by substantially reducing downgradient migration of the on-site chemicals. The potential for outward leakage through the wall is controlled by pumping a reduced amount of water inside the wall to keep the ground water level inside the wall lower than the level outside. This insures that seepage through the wall will be inward toward the

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April 11, 2003

Inquip Associates
P. O. Box 6277
McLean, VA 22106

Attention: Mr. James Edwards

Re: Slurry Trench Depth and Closure Comment
Solutia Site R
Sauget, Illinois
MRCE File P03-070

Dear Jim:

This letter provides our comments and experience with deep slurry trench barriers. The slurry trench system is stable and workable to great depths; feasibility is controlled by length of alignment and economics. We have designed and inspected construction of slurry trench barriers to depths on the order of 105 ft. A list of slurry trench projects with depth greater than 80 ft is provided below.

Deep Slurry Trench

Hydraulic excavators were outfitted with extended sticks which permitted excavation to depths on the order of 103 ft in the late 1980's. Prior to this time extended stick equipment was generally limited to 80 ft depth, and clamshell tools were used to complete trenches to greater depth. We understand that you intend to perform the Solutia project using both excavator and clamshell tools. This combined system is capable and proven. The clamshell is a valuable tool for maintaining the trench bottom clean of debris beyond the reach of the excavator.

Based on our calculations for this project (previously addressed), a deep trench at this site will be stable. Because the groundwater is fresh (not saline), liquid bentonite slurry will remain a stable colloidal suspension. Backfill performance and placement should not be affected by the greater depth.

We reviewed our list of slurry wall and slurry trench projects, which we provided with our previous letter, and spoke to others to develop the following slurry trench projects as references of comparable depth:

Project	Location	Contractor	Depth	Tools
Honeywell	Baltimore, MD	CONTI	103 ft	Excavator
Pierremont	Shreveport, LA	INQUIP	88 ft	Excavator clam
OK Tool	Milford, NH	INQUIP	110 ft	Excavator clam
Oyster Creek	Forked River, NJ	ICOS	110 ft	Excavator clam (GJT-ICOS)
Edgewater Landfill,	Indianapolis, IN	ICOS	120 ft	Excavator clam (CR-ICOS)

Closure With Bedrock

You have indicated that closure to the bedrock surface, without a key, has been questioned. We have been involved with several projects in which the key has not been constructed, yet seepage performance has not suffered. We believe construction quality control is required to confirm that the bedrock surface has been encountered, and natural soil layers have been cleared so that the backfill will contact the bedrock surface. Use of a clamshell for bottom excavation and maintenance prior to backfilling will benefit contact closure.

The Pierremont Hospital barrier which we designed for Inquip had contact closure with bedrock because the soil overburden was unstable and chiseling could not be performed. A large portion of the OK Tool project also had contact closure, where glacial till was not present. These cutoffs controlled groundwater superbly.

Please do not hesitate to contact us if you have any questions.

Very truly yours,

MUESER RUTLEDGE CONSULTING ENGINEERS

By: Peter Deming
Peter Deming

PWD:chs:ltr-02

ATTACHMENT B